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(19)

(54) EXTRUDER

(71) We, HERMANN BERSTORFF MASCHINBAU GmbH, a body corporate organised and existing under the laws of the Federal Republic of Germany, of 3 Hannover-Kleefeld, An der Breiten Wiese 3/5, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an extruder for working thermoplastics synthetic materials and rubber-like compositions, and especially for homogenising, crushing and mixing plastics compositions in a cylindrical casing surrounding the screw.

An extruder has been previously proposed having a screw with transverse webs disposed in the grooves of the screw and longitudinal webs on the outer periphery of the lands of the screw, the distance between the outer edges of the longitudinal webs and the inner wall of the casing being greater than the running clearance with respect to the inner wall of the casing.

A screw geometry of this kind results in the creation of so-called flow-division zones which enable the stream of material to be repeatedly divided up and reunited in a controlled manner.

It is questionable whether an extruder with a screw formed in this manner provides a satisfactory solution to the problem in question. Also production of such screws is difficult and costly since they cannot be produced with existing means.

Production of such screws must depend largely upon manual skill, and continuously operating milling and boring machines cannot be used for providing a screw geometry of this kind. For the most part therefore, these screws cannot be produced in batches, but only one at a time, and this is accompanied by the well-known economical disadvantages.

According to the invention, there is provided an extruder for working thermoplastics synthetic materials and rubber-like compositions, comprising a screw mounted in a cylindrical casing, the screw having a land or lands defining a groove or grooves and flow-resisting elements mounted in the groove or grooves and spaced from the land or lands, which elements each partially obstruct the groove or the respective groove of the screw, the land or lands of the screw having openings therein so disposed that a trailing end of each opening, having regard to the direction of rotation of the screw, lies on a normal to the direction of the groove which passes through the central point of that one of the flow-resisting elements which lies adjacent to the opening and on the side of the land which is towards the output end of the extruder, the openings being so dimensioned that the area of each opening is equal to that part of the cross-sectional area of the groove or respective groove which is obstructed by the adjacent flow-resisting element.

Such an extruder can be produced largely mechanically, without great difficulty and economically, but nevertheless can create flow-division zones and provide excellent mixing and homogenising actions.

The flow-resisting elements may be cylindrical, or rhomboidal or square in section, two of the edges of the square or rhomboid being aligned in the direction in which the groove or grooves of the screw extend, and both of said edges being chamfered.

The flow-resisting elements are preferably pre-shrunk and then engaged in holes formed in the screw, so as to be an interference fit in the holes, this arrangement greatly facilitating production on an economical basis.

The invention is diagrammatically illu-

strated by way of example in the accompanying drawing, in which:—

Figure 1 is a perspective view of the screw of an extruder according to the invention having cylindrical flow-resisting elements and correspondingly disposed openings in the lands, and

Figure 2 shows a developed view of a portion of the screw of the extruder of Figure 1, two different shapes of flow-resisting element being shown.

Referring to the drawing, a single-thread or multi-thread extruder screw 1, to be rotated in the direction indicated by arrow 26 and thereby to feed material in the direction of arrow 25, has lands 2, 3, 4 and 5 interrupted by openings. The leading edge of the land defining each opening lies on a line normal to the direction of the groove and passing through the central axis of a respective flow-resisting element 6, 6*a*, 7, 7*a*, 8, 8*a*, 9 and 9*a*, this axis being indicated, for the elements 7 and 7*a* by the broken line 27 in Figure 2. Such arrangement of the flow-resisting elements enables fifty percent of the volume of material filling each groove of the extruder screw to pass through the openings in each land and to travel into the adjacent groove.

The passage of material from one groove of the extruder screw 1 to another is made possible by the particular arrangement of each flow-resisting element. Material passing through an opening in one of the lands into the adjacent groove of the extruder screw 1 mixes with the material in this adjacent groove and, after it reaches a flow-resisting element in this groove, it again becomes divided.

This mixing process is illustrated in Figure 2 in which the mixing process is indicated by arrows showing direction of flow.

In the groove between the lands 4 and 5, the material flows in the direction indicated by arrow 10 and, after it has reached the flow-resisting element 9*a*, which blocks at most fifty percent of the cross-sectional area of the groove, and is preferably of a height less than the depth of the groove, the material becomes divided. The area of an adjacent opening 4*a* in the land 4 is at most fifty percent of the cross-sectional area of the groove of the screw. This ensures that, after the material has reached the flow-resisting element 9*a*, at most fifty percent of its volume passes in the direction indicated by arrow 11 into the adjacent groove between the lands 3 and 4. The rest of the material remains in the groove between the lands 4 and 5, flows in the direction indicated by arrows 12 and 14 and is subjected to intensive mixing as a result of having to circumvent the flow-resisting element 9*a*.

The material that flows over the top of the flow-resisting element 9*a* in the direction indicated by arrow 13 is in particular subjected to an intensive shearing action and homogenisation.

The material that flows in the direction of the arrow 11 and passes into the groove between the lands 3 and 4, is united with material flowing in the direction indicated by arrow 15. This union of the two streams 11 and 15 of material causes part of the stream 11 of material passing over the flow-resisting element 8*a* to be sheared into streams of material flowing in the directions indicated by arrows 17, 18 and 19.

The material passing into the groove between the lands 3 and 4 automatically causes part of the stream 15 of material, after having reached the flow-resisting element 8*a*, to flow in the direction indicated by arrow 16 through an adjacent opening 3*a* in the land 3 and on into the groove between the lands 2 and 3. This process is repeated after the stream 16 of material has become united with a stream of material 20 and is forced through an adjacent opening 2*a* in the land 2 in the direction of arrow 21 by the flow-resisting element 7.

As a result of the flow-resisting elements opposing movement of the material in the grooves of the extruder screw, and of the provision, in the lands, of a respective opening adjacent each flow-resisting element, the various streams of material are caused to mix in a very intensive manner. An intensive rubbing action in the material, i.e. an intensive shearing action, is achieved by the material passing through the gaps in the lands into adjacent grooves of the extruder screw and by some of the material flowing over the flow-resisting elements and some of it flowing round these elements. Thus, it will be readily appreciated that an excellent mixing, crushing and homogenising action can be achieved by the extruder screw.

Comparison of an extruder according to the invention with previously proposed extruders shows that an extruder according to the invention can be produced more easily and cheaply and that in addition it provides better mixing, crushing and homogenising actions.

An extruder according to the invention can be produced in conventional manner and using known means, i.e. normal screw-cutting and finish-machining operations are carried out. Thereafter, openings are formed along the length of the lands by milling. To enable the flow-resisting elements to be inserted in the core of the screw, holes are drilled in the core of the screw. The flow-resisting elements are slightly shrunk by cooling them in liquid nitrogen for example, and in this cooled condition are inserted into the holes.

The flow-resisting elements are thus secured in the core of the screw in a simple and relatively cheap manner.

Instead of cylindrical flow-resisting elements, square or rhomboidal section elements each with a round base can be shrunk into the core of the screw, two diagonally opposite edges of the square or rhomboid being aligned with the direction in which the groove of the screw extends, and these edges being chamfered to avoid the formation, to the rear of the elements, of spaces into which material cannot flow.

WHAT WE CLAIM IS:—

1. An extruder for working thermoplastics synthetic materials and rubber-like compositions, comprising a screw mounted in a cylindrical casing, the screw having a land or lands defining a groove or grooves and flow-resisting elements mounted in the groove or grooves and spaced from the land or lands, which elements each partially obstruct the groove or the respective groove of the screw, the land or lands of the screw having openings therein so disposed that a trailing end of each opening, having regard to the direction of rotation of the screw, lies on a normal to the direction of the groove which passes through the central point of that one of the flow-resisting elements which lies adjacent to the opening and on the side of the land which is towards the output end of the extruder, the openings being so dimentioned that the area of each opening is equal to that part of the cross-sectional area of the groove or respective groove which is obstructed by the adjacent flow-resisting element.

2. An extruder according to Claim 1, in which the flow-resisting elements are cylindrical.

3. An extruder according to Claim 1, in which the flow-resisting elements are square or rhomboidal in section, two of the edges of each such elements being disposed in the direction in which the groove or grooves of the screw extend, and both of said edges being chamfered.

4. An extruder according to any one of Claims 1 to 3, in which the flow-resisting elements are pre-shrunk and then engaged in corresponding holes formed in the screw so as to be an interference fit in the holes.

5. An extruder comprising a screw mounted in a cylindrical casing, substantially as hereinbefore described and illustrated with referance to the accompanying drawings.

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Fig. 1

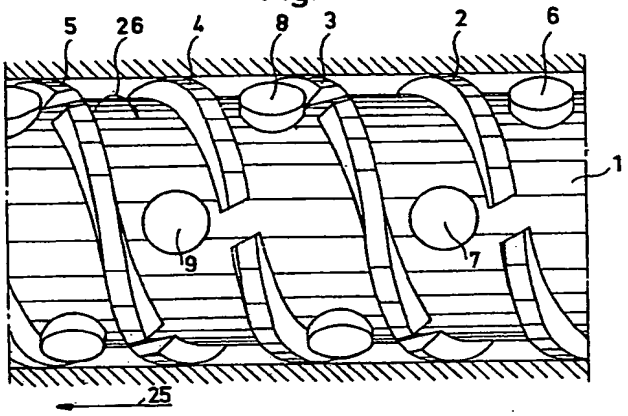

Fig. 2